1245 this was turned into French metre by the Duc de Berry; in 1464 this was turned into French prose, and from this text Caxton took his translation.

Even abroad the proportion of scientific to other classes of works issued from the early printing presses was comparatively small; but this may be satisfactorily enough accounted for by the fact that there were then comparatively few really scientific works in existence. From the Italian presses a very large number of arithmetical and geometrical works were issued at the end of the fifteenth and beginning of the sixteenth century. The Alphonsine tables were printed at Venice in 1483; but one of the earliest works in any way connected with science must have been a folio sheet, "Conjunctiones et oppositiones solis et lunæ," dated 1457; the place of publication we have been unable to ascertain. There is a "Gerardis Cremonensis Theoria Planetarum," quarto, dated 1472, and an Albertus Magnus "Opus de Animalibus," printed at Rome in 1478. Other early printed works which, considering the time, may be classed as scientific, are "Questiones Johannis Cunonici super octo libros Physicorum Aristotelis" (Padua, 1475); "Garetani de Thienis in Meteor. libros Aristotelis Expostio" (Padua, 1476); "Prognosticon," a meteorological work published at Venice in 1485. But when we come into the next century the number of strictly scientific works published in England and other European countries increased with amazing rapidity, and we may say has gone on increasing in ever enlarging proportion ever since. The first English translation of Euclid by Billingsby is said to have been published in 1570.

It is a small thing that books of science are all but unrepresented in the Caxton Exhibition; these could no doubt have been obtained had they been sought for; but the object of the exhibition is simply to illustrate the origin and growth of the art of printing, which has been an inestimable boon to science as it has been to every other form of human activity, and the man of science owes as much gratitude to its inventors, and to Caxton its ntroducer into England, as does the worker in any other department of culture. Happily, as we hope to show, science has been able to some extent to repay her debt by importing improvements into the art which would not have been possible but for her researches.

THE DEVELOPMENT OF THE OVUM

Bütschli on the Earliest Developmental Processes of the Ovum, and on the Conjugation of Infusoria.

Studien über die ersten Entwicklungsvorgänge der Eizelle, die Zelltheilung und die Conjugation der Infusorien. Von O. Bütschli. (Frankfurt, 1876.)

FEW subjects can be more important in their bearing on biology than the more prominent of those considered in this volume. It now rests on a morphological basis which will never be shaken, that there has been a procession of the most complex animal forms from simpler and still simpler ones, until we reach eventually the ultimate of organised simplicity. There may be difficulties n the way, but they are as nothing to the overwhelming evidence which morphology provides in its support; doubt, indeed, is no longer possible; and every year diminishes the circumscribed area of difficulty. But our knowledge hitherto of the developmental processes which take place in the earlier states of the simplest elementary organisms is wholly incompetent. Much labour has been expended, and doubtless good work has been done; but as it at present stands, it is conflicting, crude, and essentially wanting in coincidence and correlation. The work before us is the result of an attempt on the part of its author to penetrate farther into the matter than his predecessors, and by completer knowledge to harmonise or explain away conflicting evidence and doubtful interpretation, and if possible to give a sequence to the morphological processes in the simplest ova, and in the least apparently organised of animal forms.

From the smallness of the space at our disposal all consideration of the second subject discussed in this volume must be passed over. It deals with cell and nucleus fission generally; but as it is chiefly theoretical, we may the more readily omit it, merely remarking that the author concludes that there is a fundamental harmony in the method of fission in the cells of both animals and plants; a conclusion which it may be fair generally to admit; but in the minute detail, only discoverable by prolonged research, there will be found palpable differences.

That which gives distinction, and to some extent importance to the book, is (1) its minute and practical investigation into the earliest changes effected by development in the ova of some of the more lowly organised animal forms; and (2) the abundance of data which it appears to provide for the support of a new theory of propagation amongst the infusoria, which Bütschli propounds and advocates.

The embryological researches under the first head were conducted principally upon the ova of the Nematoid worms and the Rotifers. To a limited extent the living egg was studied; but the greater part of the results are derived from investigations of the ova treated with acetic acid. This is greatly to be regretted. The difficulties which present themselves in the minute examination of such ova in the living condition, are doubtless great, indeed complete results could scarcely be obtained from this alone. But undoubtedly the continuous examination of a set of living ova in process of development should be carried on simultaneously with every method of treatment which will reveal structure and change in ova of the same form in the dead condition. Only in this way can every possible mutation be traced, and its correlation and sequence be established.

It is extremely difficult to distinguish even striking discoveries in this direction from the manifold claims put forward by the many observers. We must state generally the facts as they at present appear, and seek to indicate the points specially claimed as new by Bütschli. It is now well known that the ovum is not suddenly formed, and then stimulated into new activity by fertilisation. It evidently, in its very lowliest condition, goes through a process of internal growth and development; after which apparently it perishes unless fecundated. In 1864 Balbiani endeavoured to prove that besides the *germinal vesicle*, there existed one still more important, which he called the embryogenic cell or vesicle in the ovarian ovum; and it was held by leading embryologists

that it was round this cell that the true embryo was constituted; but in what manner, each observer appears to have determined for himself. The disappearance of what was accepted as the germinal vesicle was generally agreed to; but whether before or after impregnation was never fully determined. That it merely retrograded to the centre and determined segmentation as the result of fecundation, was held by many; while the embryogenic vesicle was said to persist, and from it were derived the now celebrated "globules polaires," or "Richtungsbläschen," which had been variously called by different writers from Carus downwards "white vesicles," "round vesicles," "clear globules," and so forth, and which are now thought to enter directly into the genital organs of the future being; Balbiani considering them of much importance in the evolution, inasmuch as they are found just in the region of the ventral layer of the blastoderm where the genital organs appear.

We have only space for a consideration of one of the instances adduced by Bütschli of earliest ovum development; but that may suffice to indicate the distinctive nature of his work. We select the eggs of *Nephelis vulgaris*. In their youngest state, the yolk is retracted from the delicate membrane, and there is, resting on the yolk, a minute mound of spermatozoa. At a little distance from this spermatozoal eminence there is an eccentrically placed spindle-shaped body, composed of fine longitudinal fibres, which at the equator of the spindle are swollen to a thick shining granular zone. The yolk mass is depressed at one point, and the spindle has its long axis directed to that of the flattened yolk. At the ends of this body there are clear homogeneous spots, from which rays go forth in all directions through the yolk. This spindle-shaped body Bütschli affirms to be the true *germinal vesicle*; and it is this which is carried upward to the surface of the yolk, by the elevation of the upper set of rays proceeding from the homogeneous spot over its upper apex, until eventually this spindle is pushed out of the yolk in three segments. In the part first protruded fine granules appear, and these retain their connection with the fibres in the part still inclosed in the yolk, by fine filaments, which also terminate in a zone of granules. This protruded vesicle is the "Richtungsbläschen;" the real place and relation of which, in the subsequent development of the egg, is nowhere determined by these researches. In the stage of partial protrusion of this vesicle, at about a quadrant from the point of its exit, another clear space arises sending out its radial rays; this enlarges, moves to the centre, and the germinal vesicle—now the "Richtungsbläschen"—is at this time quite protruded. At a point in the yolk determined by the point of exit of the "Richtungsbläschen," two minute nuclei appear, one in the upper margin of the clear space, and the other between that and the point of exit of the said vesicle. They are at first entirely disconnected, and both, by treatment with acetic acid, prove to be true nuclei. But they soon unite in the clear spot or space, and, at its expense, rapidly grow. They become a perfect nucleus with a distinct envelope and fluid contents, and distributed within the latter are dark granules. While these processes have been taking place two of the three segments of the "Richtungsbläschen" have again united, and at the same time the transformation of the nucleus begins. At two points on opposite sides of the nucleus, and in the direction of the long axis of the yolk, there arise clear spots and their accompanying rays. Between these, the nucleus differentiates itself into long fibres, and becomes a spindle-shaped body exactly like the germinal vesicle. An equatorial zone arises in it which is called a nuclear-band (kernplatte), which now divides; and each half recedes to the opposite ends of the spindle-like body. These ends now lose their points and become rounded, and in the mean time occurs the furrowing or constriction of the yolk. Another equatorial band arises in the nucleus or spindle, and when the constriction of the yolk is half accomplished the formation of nuclei of the second generation takes place from the ends of the spindle, these being nuclei in the completest sense. These fuse together and grow at the expense of the clear space—the growth of the nuclei and the diminution of these homogeneous spaces being in all cases correlative. When these nuclei are developed both hemispheres of the yolk collapse, and an almost spherical shape is again resumed.

What became of the fibres of the spindle was never discovered, but about this time the remaining segments of the "Richtungsbläschen" reunite, and in it a system of fibres appears. The following fission processes are but repetitions of this.

It becomes from the above apparent that Bütschli takes it for granted, first, that the eggs studied had been subject to no earlier developmental changes than those with which he starts. Next, that there can be no question as to the identity of his "spindle-formed body" and the germinal vesicle. He further at first claimed the extrusion of this germinal vesicle as the "Richtungsbläschen," as a sole result of the stimulus of impregnation; and ventures to consider that the process of nucleus formation described is widely diffused in the animal world, and that it is probably universal in impregnated eggs.

But (1) there is not the remotest evidence to show that processes of considerable import may not have preceded the condition with which these investigations started; complex processes are still known to occur in the unimpregnated ovum. We have only indeed to turn to the next example given by Bütschli himself to prove all this. In *Cucullanus elegans* the ovum leaves the ovarium without an envelope; and within the yolk is seen the "large *round* germinal vesicle and the germinal spot." The latter vanishes after impregnation, and the germinal vesicle becomes eccentric—and the next thing we are told is that "the germinal vesicle was no longer in the yolk, but *instead of it* there was a spindle-shaped something like that seen in Nephelis." How was the change effected? What were the steps? The transition is all-important, but how it happened is not worked out; and it would be, in so important a question, a matter of the greatest interest to know *how* the perfect spindle-formed body, with which these observations begin, arose. Nothing final can issue in this inquiry until, from first to last, every process and every step therein has been consecutively made out.

(2) The identity of this body with what is known as the germinal vesicle is certainly probable, but by no means certain, at present. It is certainly true that this supposition derives considerable support from the fact that Ratzel

found that in the ripe ova of *Tubifex*, prior to laying, the spherical germinal vesicle lost its spherical shape, elongated, became spindle-shaped with a meridional striation, and so forth, closely resembling the nuclear spindle of *Nephelis*. But as the process is described by Bütschli this would involve the necessity that the *whole* of the germinal vesicle was extruded as the "Richtungsbläschen" in every case. Against this, however, there are irresistible facts; and in an appendix to the volume the author is bound some sense to admit that there are cases where "a part of the germinal vesicle may remain." If this be so evidently there is missing a link in the chain of observation. Difficulties of an equally complex character present themselves in the collation of these researches with those of other distinguished embryologists which it would be hopeless even to attempt to consider here.

3. That the expulsion of the "Richtungsbläschen" is a result of impregnation must also be abandoned. In the text of this treatise the author earnestly contends for this point nevertheless; and endeavours to dispel the force of the very definite results of Œllacher, Bischoff, Flemming, and Beneden. But these are points that may be settled with comparative ease, and it certainly is true that the expulsion of the "Richtungsbläschen" may show itself as one of the earliest phenomena of development in the unfertilised egg. This is now admitted, and in the appendix is allowed by Bütschli.

4. The universal application of the method of development seen in *Nephelis*, although strongly contended for, and carried by analogy into the interpretation of the theory advanced in the third part of the volume to account for the propagation of Infusoria, can only be admitted with the utmost caution. The evidence given by the author is by no means perfect. In *Cucullanus elegans*, for example, he admits that the transition of the nucleus spindle into the "Richtungsbläschen" cannot be made out as in *Nephelis*, but contends that it *ought not to be doubted*. And precisely the same difficulty attaches to the transformations of the nucleus, of which "nothing could be certainly found;" yet the same doctrine is carried over, as though precisely the same phenomena had been witnessed as in *Nephelis*. So in relation to other Nematoids, it is rather inference than evidence that the protruded vesicle is the germinal vesicle, as in *Nephelis*. So in *Limnæus auricularis*, essential points in the origin and subsequent evolution of the spindle and nuclei are presented, not as the result of observation, but of inference, and a leap across a chasm between two preparations of the ovum which show no continuity of evolution, is taken with an assurance that "doubtless," although the intermediate process was not made out, we might be guided by the analogy of *Nephelis*.

These facts are pointed out, not in the slightest degree to detract from the value of the author's observations, but simply to separate them, as such, from the inferences he draws from them. There can be little doubt that great value belongs to the discovery of the nucleus spindle and its behaviour in evolution; and there can also be little question that it is largely original research; but its relation to anterior and subsequent processes is not so definitely discovered. It is nevertheless a source of great interest to find that Balbiani has given such complete and recent confirmation to the main characteristics of the spindle-nucleus.[1] It is true that he does not confirm the division of the equatorial band in the nucleus, and claims to have shown the existence of the clear spaces and rayings accompanying the nucleus-transformations in the eggs of spiders four years before. But evidently a step is gained by these observations on the earliest development of the ovum; although, from the careful work of M. Fol, it is clear that not only the interpretation, but the detail, may be open to question.[2]

W. H. DALLINGER
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(*To be continued.*)

THE ALKALI TRADE

The History, Products, and Processes of the Alkali Trade, including the most Recent Improvements. By Charles Thomas Kingzett. (London: Longmans, Green, and Co., 1877.)

TOWARDS the middle of last century the price of oil of vitriol was 130*l*. per ton; the same substance now sells at 5*l*. per ton. In the first years of the present century soda crystals sold at about 60*l*. per ton; their present price is about 4*l*. 15*s*. per ton.

In 1861 the Lancashire district produced 8,800 tons of soda crystals, 4,600 tons of caustic soda, and 11,700 tons of bicarbonate of soda. The same district consumed, in that year, 161,000 tons of sulphuric acid and 135,000 tons of salt. Five years later (1866) 194,000 tons of salt were consumed in the same district, while the out-put amounted to 25,000 tons of soda crystals, 11,000 tons of caustic, and 6,500 tons of bicarbonate, together with 87,000 tons of soda ash and refined alkali, and large quantities of bleaching liquor, bleaching powder, &c. The following numbers, obtained from the Alkali Association, show the increase in the alkali trade of the United Kingdom between the years 1862 and 1876:—

	1862.	1876.
Annual value of finished products	£2,500,000	£6,500,000
Weight of dry products ...	280,000 tons.	845,000 tons.
Raw materials used:—		
Salt	254,600 ,,	538,600 ,,
Coals	961,000 ,,	1,890,000 ,,
Limestone and chalk ...	280,500 ,,	588,000 ,,
Lime	—	139,000 ,,
Pyrites	264,000 ,,	376,000 ,,
Nitrate of soda	8,300 ,,	12,200 ,,
Manganese	33,000 ,,	18,200 ,,
Total	1,801,400 tons.	3,562,000 tons.
Capital employed in the business	£2,000,000	£7,000,000
Hands employed	10,600	22,000
Wages paid them annually..	£549,500	£1,405,000
Weight of soda exported ...	104,762 tons.	270,856 tons.
Value of exported soda ...	£885,245	£2,209,284

These facts enable us to form some idea of the enormous growth of the alkali trade within recent years. This growth has been in a large measure coincident with

[1] Sur les Phénomènes de la Division du Noyau Cellulaire, *Comptes Rendus*, Oct. 30, 1876.
[2] Sur les Phénomènes Intimes de la Division Cellulaire, *Comptes Rendus*, Oct. 2, 1876.